Developing a Measure for the Dietary Guidelines Recommendation to Eat a Variety of Foods

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Eating a variety of foods—especially whole grains, fruits, and vegetables—ensures the intake of many of the nutrients and other substances essential for good health. Measuring variety is complex, and many different definitions have been proposed. Eating a variety of foods is one of the Dietary Guidelines for Americans—though written in slightly different terms in some of the 5-year updates since the Guidelines were first introduced by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS) in 1980. An application of the variety guideline is a component of the USDA's Healthy Eating Index (HEI), a summary measure of overall diet quality that measures compliance with the Guidelines. This report explains the methodology of the HEI's variety measure, as calculated by the USDA Center for Nutrition Policy and Promotion (CNPP). CNPP uses four main databases to construct the variety measurement: the Food Guide Pyramid Servings Database, the Recipe Database, a list of distinct foods, and a dietary intake database. An HEI variety score is assigned between 0 and 10 points, with eight or more different or "unique" foods consumed during 24 hours earning 10 points; three or fewer unique foods, 0 points. To demonstrate this methodology, we applied the HEI variety measured to the U.S. population by using dietary intake data from the National Health and Nutrition Examination Survey 1999-2000 to estimate 1-day dietary variety in the United States.

Since the first edition of the *Dietary Guidelines for Americans* in 1980, the U.S. Department of Agriculture (USDA) and the U.S. Department of Health and Human Services (DHHS) have recommended eating a variety of foods to ensure individuals consume all essential nutrients for both general health and chronic disease prevention (USDA & DHHS, 1980; USDA & DHHS, 1985; USDA & DHHS, 1990; USDA & DHHS, 1995; USDA & DHHS, 2000). Over the course of the five editions, guidance has evolved: "eat a variety of foods" (1980, 1985, 1990, 1995), "choose a variety of grains daily, especially whole grains" (2000), and "choose a variety of fruits and vegetables daily" (2000). The five food groups consist of grains, vegetables, fruits, milk and milk products, and meat and beans. No single food or food group supplies adults and children 2 years and older with all the essential nutrients and other important food substances in the amounts needed for good health. Analysis of data from the first National Health and Nutrition Examination Survey (NHANES I) Epidemiologic Follow-up Study demonstrated that those who consume foods from only one or two food groups had a significantly higher risk of all-cause mortality. This was the case even after other major risk factors such as race, education, smoking, and dietary fiber consumption were controlled (Kant, Schatzkin, Harris, Ziegler, & Block, 1993).

Whole grains, fruits, and vegetables contain concentrated amounts of vitamins, minerals, antioxidants, dietary fiber, phytochemicals, and

other substances that may protect against several chronic diseases. For example, increased consumption of good sources of dietary fibers—such as grains, fruits, vegetables, and beans—can lower blood cholesterol levels; help to regulate blood sugar; and lower the risks of cardiovascular disease, diabetes, and colon cancer (Marlett, McBurney, & Slavin, 2002). Similarly, regular consumption of whole grains has been associated with a reduction in cardiovascular disease, diabetes, cancer mortality, and premature death (Lang & Jebb, 2003).

A recent research review illustrated that while there are thousands of beneficial plant substances, no *single* plant substance alone provides the protective effects from chronic diseases. Also, when these plant substances are taken as supplements rather than consumed as they naturally occur in plant products, their protective effects are minimal (Buttriss, 2004). Therefore, the basis for recommending a variety of whole grains, fruits, and vegetables is well founded.

Within the nutrition field, the definition of variety is inconsistent; and misinterpretation of the term can potentially lead to confusion or unintended consequences. Focus group research on the 2000 Dietary Guidelines found that consumers interpreted eating a "variety" to mean that one should eat foods from all food groups, which may lead to eating a variety of foods high in fat and added sugars (Prospect Associates, 1998).

Methods used to measure variety also matter in examining the link between food consumption and health outcomes. Researchers have used at least three different methodologies to measure variety: (1) count the number of unique foods[1] (used in our methodology) (Bernstein et al., 2002; Krebs-Smith, Smiciklas-Wright, Guthrie, &

Krebs-Smith, 1987); (2) count the number of foods from each Pyramid food group (Kant et al., 1993; Kim, Haines, Siega-Riz, & Popkin, 2003); and (3) divide foods as consumed into groups (Drewnowski, Henderson, Driscoll, & Rolls, 1997; Haines, Siega-Riz, & Popkin, 1999; McCrory et al., 1999; Wirfalt & Jeffery, 1997). For example, the first two methods would classify a vegetable stir-fry by the unique foods it contains (e.g., onions, carrots, and string beans); the third method would classify this mixed dish as a "vegetable stir-fry."

In 1995, the USDA Center for Nutrition Policy and Promotion (CNPP) constructed the Healthy Eating Index (HEI) to measure individuals' overall diet quality based on current dietary guidance, including the Dietary Guidelines for Americans as well as the Food Guide Pyramid—a teaching tool developed by the USDA in 1992 that includes the messages of the Guidelines. The HEI measure consists of 10 components worth 10 points each, for a perfect score of 100. For each component, scores are assigned proportionately from no compliance with the recommendation (0 points) to full compliance (10 points). Five components measure whether the individual consumes the recommended number of servings from each of the five Pyramid food groups for his or her age and gender group. The next four components measure the compliance with dietary recommendations of total fat, saturated fat, cholesterol, and sodium. The detailed methodology for these nine components is described elsewhere (Basiotis, Carlson, Gerrior, Juan, & Lino, 2002).

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[1]"Unique foods," "distinct foods," and "commodities," as used in this report, refer to a basic non-mixed food. These foods may be from mixed dishes that have been aggregated into agricultural commodities. For example, pizza is considered wheat-based bread dough, cheese, tomato sauce, mushrooms, and so forth.

The measurement of the HEI's variety component is complex. There is a lack of scientific evidence on the exact number of different foods that should be consumed per day to achieve the benefits of meeting nutrient recommendations and protection from disease outcomes. Additionally, the benefits of consuming a variety of foods seem to stem from eating a variety of unique agricultural commodities (Buttriss, 2004; Kim et al., 2003), not from consuming a variety of food mixtures made up of the same commodities. For example, a vegetable stir-fry might contain the same ingredients as a vegetable soup; these would be considered different food mixtures but are made up of the same commodities. Thus, we base our measure on eating a variety of commodities. In the best professional judgment of USDA nutrition staff, eight different unique foods is considered a sufficient number; whereas, three unique foods is considered insufficient.

It is important to understand the differences between the variety measures, because the effect of the recommendation to eat a variety of foods changes with respect to overall diet quality, nutrient adequacy, and obesity. Bernstein and colleagues (2002) defined variety as the number of different foods consumed. Using this definition, they found that elderly nursing home residents who ate a wider variety of foods had better nutritional status.

On the other hand, Drewnowski's team (1997) grouped foods (including mixed dishes) into 147 groups and counted the number of different groups consumed by 24 younger and 24 older respondents. The results demonstrated that the older adults consumed a more varied diet; and higher dietary variety was associated with higher intakes of vitamin C and lower intakes of salt,

sugar, and saturated fat. This team defined diet quality on a 5-point scale with 1 point each for limiting consumption to the recommended amounts of total fat, saturated fat, sodium, and cholesterol, and a fifth point for eating at least half of calories as carbohydrates. These definitions of variety and diet quality led the team to conclude that dietary variety was not related to overall diet quality.

Stallings, Wolman, and Goodner (2001) used the HEI score to measure variety based on the previous CNPP Variety Database and diet quality among 208 low-income women in South Carolina. They found no statistical difference in the variety score between the normal weight group and the overweight, obese, and extremely obese groups based on BMI. Thus, based on this measure, we can conclude that individuals who are normal weight do not consume a less varied diet than those who are overweight or obese. Using data from NHANES 1999-2000 and the previous CNPP Variety Group List containing nearly 350 distinct foods,[2] Basiotis, Carlson, and Murphy (2003) found that compared with their normal-weight counterparts, obese men have less variety in their grain and fruit consumption, while obese women have less variety in their fruit consumption.

Hann, Rock, and Drewnowski (2001) also used the HEI to measure both overall diet quality and variety of the diet among 340 women participating in a case-controlled study of breast cancer. To conduct this study, they used 3-day food records. And like Basiotis and colleagues (2002), Hann and colleagues also used the previous CNPP Variety Group List. The results showed that dietary variety and fruit

intake were the strongest predictors of the variation in overall diet quality. The group with the best diets (total HEI score greater than 80 points of a possible 100) consumed nearly twice as many foods as did the group with poor diets (less than 65 points). The results also showed that the HEI score correlates positively with biomarkers such as circulating plasma carotenoid and plasma vitamin C.

Using the updated Variety Group List and data from adults participating in the Continuing Survey of Food Intakes by Individuals (CSFII) 1994-96, Foote, Murphy, Wilkens, Basiotis, and Carlson (2004) found that increased dietary variety, especially in the grain and milk and milk products groups, increased the mean nutrient adequacy of 15 nutrients. Furthermore, the team found that variety counts had a greater effect on the individual's mean adequacy ratio than did the number of Pyramid servings.

In this report, we outline the method used to calculate the HEI variety score. We also present summary results of the variety score for the U.S. population by using 1-day dietary intake data from NHANES 1999-2000.

Data

The HEI variety score calculation uses four main data sets: the Food Guide Pyramid Servings Database, the Recipe Database, a list of distinct foods, and a dietary intake database. The Food Guide Pyramid Servings Database was developed by the USDA Agricultural Research Service and contains the number of Pyramid servings in 100-gram weights of more than 7,000 USDA survey food codes. The Recipe Database contains a list of ingredients and quantities of each food with an 8-digit USDA survey food code. Both of these databases were developed by

using data from the Continuing Survey of Food Intake by Individuals (CSFII) 1994-96.

The third database is a list of 289 distinct foods or commodities developed by CNPP and the Cancer Research Center at the University of Hawaii. Examples of distinct food items from the grain group include whole-grain rice, pasta and macaroni, and refined wheat products. Pasta and macaroni are separated from other wheat products because pasta and other wheat products are made from different wheat grains. Each distinct food is assigned to one of the Pyramid subgroups (table 1).

The fourth database is any database containing 24-hour dietary data, coded with USDA 8-digit food codes. For example, when the initial HEI methodology was developed in 1995, we used data from CSFII 1994 to measure the quality of Americans' diets. For the illustration of the methodology in this report, we used data from NHANES 1999-2000 to estimate the average variety score and the average unique food consumption for individuals in the United States.

Methodology

The HEI variety calculation consists of two main steps: (1) creating the CNPP Food Variety Database and (2) calculating the variety score for an individual's food intake for 1 day.

Step One: Creating the CNPP Variety Database
The CNPP Variety Group List consists of the 289 distinct foods matched with the USDA 8-digit survey food codes, as well as the number of Pyramid subgroup servings in 100-gram weights of each food. The current list represents an improvement from the original 1994 Variety Group List that contained

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[2]Our methodology uses an updated Variety Group List that is detailed later in this report.

349 distinct foods but did not proportionately distribute fractional quantities of individual foods that were part of mixed dishes. In 2002, the Variety Groups were broken into Pyramid subgroups and the number of Pyramid servings became the basis to determine how much of each food was consumed. The Variety Group List was further refined in 2004 to reflect individual commodities, such as refined or whole-wheat products as opposed to the former, more generic "bread group." For this report, we used the current version of the Variety Group List, which was recently revised based on food commodities.

To create the CNPP Variety Database,[3] we combined the USDA Pyramid Servings Database and the Recipe Database with the Variety Group List. Each USDA food code is listed by the appropriate Pyramid subgroup, the number of Pyramid subgroup servings per 100-gram weight of the food code, and the appropriate distinct food(s) from the Variety Group List. Food codes were matched to distinct foods. If a food contained more than one distinct food from the same Pyramid subgroup, we matched the number of servings to the ingredient used in the largest amount. For example, many soups contain both onions and celery, both of which are in the "other vegetables" Pyramid subgroup. The number of Pyramid servings for this subgroup would be assigned to onions if more onions than celery were in the soup.

Step Two: Calculating the Variety Score

After the CNPP Variety Database was established, we first calculated the total quantity of each distinct food consumed in a day and then counted the total number of distinct foods consumed to assign a variety score. In the best professional judgment of USDA staff, an individual must consume at least one-half of a Pyramid serving of eight or more distinct foods throughout the day to obtain adequate amounts of nutrients and substances for a good diet and to receive a perfect score of 10 for the variety component of the HEI.

To calculate the number of Pyramid servings consumed of each distinct food, we merged the CNPP Variety Database with the NHANES 24-hour dietary intake data. We then calculated the number of Pyramid subgroup servings consumed of the distinct food represented by a USDA 8-digit food code.

We then computed the total number of Pyramid subgroup servings for each distinct food that the individual consumed in a day and eliminated any distinct foods where the total amount consumed was less than one-half of a serving. Finally, we counted the total number of distinct foods consumed in a day and assigned a variety score. Individuals who consumed eight or more distinct foods in a day received a score of 10 from 10 possible points; those who consumed three or fewer distinct foods received a score of 0. Points were prorated among three and eight distinct foods.

Application: Calculating a U.S. Variety Score by Using Data From NHANES 1999-2000

We calculated the average 1-day dietary variety score of the U.S. population by using 24-hour dietary recall data from NHANES 1999-2000 for 986 men and 1,236 women aged 20 to 50 years.[4] We also calculated this group's average number of distinct foods consumed in each of the five major food groups. Both the average variety score and the number of distinct foods provide insight on quality of an individual's or a

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[3]The current version of the CNPP Variety Database was completed in collaboration with Kim Yonemori, Suzanne Murphy, and Janet Foote of the Cancer Research Center at the University of Hawaii and is available on the CNPP Web site at www.usda.gov/Pubs/HEI/HEIVarietyPOR.exe.

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[4]The NHANES 1999-2000 is a complex, multistage probability sample of the civilian, noninstitutionalized population of the United States. Data were collected through in-person interviews with individuals of all ages. The NHANES 1999-2000 is described in detail elsewhere (Center for Disease Control and Prevention, 2003).

population's diet. When examining the number of distinct foods consumed, one must recognize that the counts are not necessarily the number of Food Guide Pyramid servings consumed. However, in our current application, we did find a correlation between the number of distinct foods consumed in a Pyramid food group and the number of total servings consumed (data not shown). A previous application demonstrated that Americans do not eat enough fruit (Basiotis et al., 2002).

Results

By using the HEI variety score methodology, we found that, from a possible score of 10, the average 1-day variety score was 7.9 for men and 7.5 for women. The average variety count was 8.3 and 7.7 for men and women, respectively (table 2). This result indicates that, on average, American men and women from this sample consumed about eight distinct foods per day. The breakdown by Pyramid food groups allows us to examine how varied Americans' diets are.

The results show that adult men and women have very similar patterns of consumption. The largest difference between men and women is in the meat and beans group, where men consumed an average of 0.3 more distinct meat and bean items than did women. It appears that the major contributors to the distinct foods in this group are from three food groups: meat and beans, grains, and vegetables. We conclude that on the day of the survey, the representative population of adult Americans aged 20 to 50 years ate a variety of meat and beans, grains, and vegetables, but not a variety of fruits.

Table 2. Average number of unique foods consumed by men and women, 1-day data[1]		
Food group	Unique foods consumed	
	Men	Women
Grain	2.5	2.4
Vegetable	1.8	1.7
Fruit	0.8	0.9
Meat and beans	2.1	1.8
Milk	1.1	0.9

[1]One-day dietary intake source data from NHANES 1999-2000 for 986 men and 1,236 women aged 20 to 50.

Discussion

Since inception in 1980, the Dietary Guidelines for Americans have recommended that Americans consume a variety of foods to obtain the nutrients and other substances needed for good health. This concept has continued through all five editions of the *Dietary Guidelines* (1980, 1985, 1990, 1995, and 2000). In 2000, research supported the distinction to specify consuming a variety of whole grains, fruits, and vegetables. Selecting a variety of foods within the groups may help to ensure that an adequate amount of nutrients and other potentially beneficial substances are consumed. Additionally, variety was one of the main messages of the original USDA Food Guide Pyramid released in 1992.

Researchers have used varying methods to measure the quality of the diet of individuals or populations. The HEI uses a commodity base to measure variety, with 289 distinct foods that count toward a variety score if an individual consumes at least one-half of a Pyramid subgroup serving. Others have counted the number of unique foods, which means two mixed dishes can each count as one item, even if they have the same ingredients.

By using the HEI variety score methodology, we found that, from a possible score of 10, the average 1-day variety score was 7.9 for men and 7.5 for women. The average variety count was 8.3 and 7.7 for men and women, respectively.

A third method is to divide mixed dishes into pre-defined groups of foods and then count the number of different groups. Researchers have also counted the number of Food Guide Pyramid food groups an individual consumes.

The USDA Healthy Eating Index uses agricultural food commodities to calculate the variety count for the variety score. This method counts different food commodities within the subgroups of the basic food groups as separate foods. The cooking method and amount of fat and sugar added does not affect the assignment to the variety group. Thus, a vegetable stir-fry and a vegetable soup may contain the same vegetable commodities, but are prepared in different ways, and the ingredients in both dishes would not be considered different foods.

In this report, we counted the number of different food commodities consumed by men and women, aged 20 to 50, from among and within each Pyramid group. The results of this analysis indicate that Americans are not eating enough variety in a single day. This is especially true within the fruit group. One way, perhaps, to encourage greater fruit consumption would be to promote the consumption of a wider *variety* of fruits every day, because some individuals may find it easier to eat more fruit if they eat different types.

Although the Healthy Eating Index is designed to measure the quality of an individual's diet over the course of 1 day, the variety consumed in a single day may not necessarily represent an individual's usual intake. However, we believe that the variety score of nationally representative data from NHANES 1999-2000 can adequately measure the dietary variety for the population in the United States. Therefore, applying our Healthy Eating Index variety measurement methodology to populations and subpopulations can provide researchers and nutrition educators with a better understanding of where attention should be focused for nutrient adequacy and its effect on overall diet quality.

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